

Sulfur Isotopic Study of Water and Sediment from Lake Fryxell, Taylor Valley, Antarctica

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Lake Fryxell is a perennially ice-covered lake located in Taylor Valley of the McMurdo Dry Valleys of east Antarctica. Benthic microbial mats containing sulfate-reducing bacteria are present in anoxic waters and sediments at depths greater than 10 m. A bulk sample of lake-bottom sediment from ~17 m water depth was obtained from within the anoxic zone. Water-column samples from 6 to 17 m depth were analyzed for sulfate content. Sulfur isotopic values ($\delta^{34}\text{S}$) were determined for sequentially extracted sulfur species in sediment and for sulfate recovered from water samples. Sulfate samples recovered from water showed increasing $\delta^{34}\text{S}$ from about 8 per mil at 6 m water depth to about 52 per mil at 17 m water depth. Sequential extraction of a bulk sediment sample showed sulfate $\delta^{34}\text{S}$ of about 21 per mil and pyrite $\delta^{34}\text{S}$ of about 15 per mil. Enrichment of ^{34}S for sulfate from bottom water in Lake Fryxell is the second highest level of enrichment reported for a natural water body. Extreme enrichment is inferred to result from near exhaustion of the benthic sulfate reservoir in Lake Fryxell by metabolism of sulfate-reducing bacteria. A Rayleigh Distillation Model suggests that nearly 70% of available sulfate in Lake Fryxell bottom water has been utilized by sulfate-reducing bacteria. Significantly lower $\delta^{34}\text{S}$ for sulfate and pyrite in bulk sediment compared to sulfate in bottom water is inferred to result from re-oxidation of microbial sulfide at some previous time.